

Greenhouse Gas Mitigation from Landfills

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Presentation



- ⌘ Methane Generation, Collection, and Control at Landfills
- ⌘ California Statistics
- ⌘ Landfill Gas Utilization
- ⌘ Challenges and Obstacles

Landfill Overview

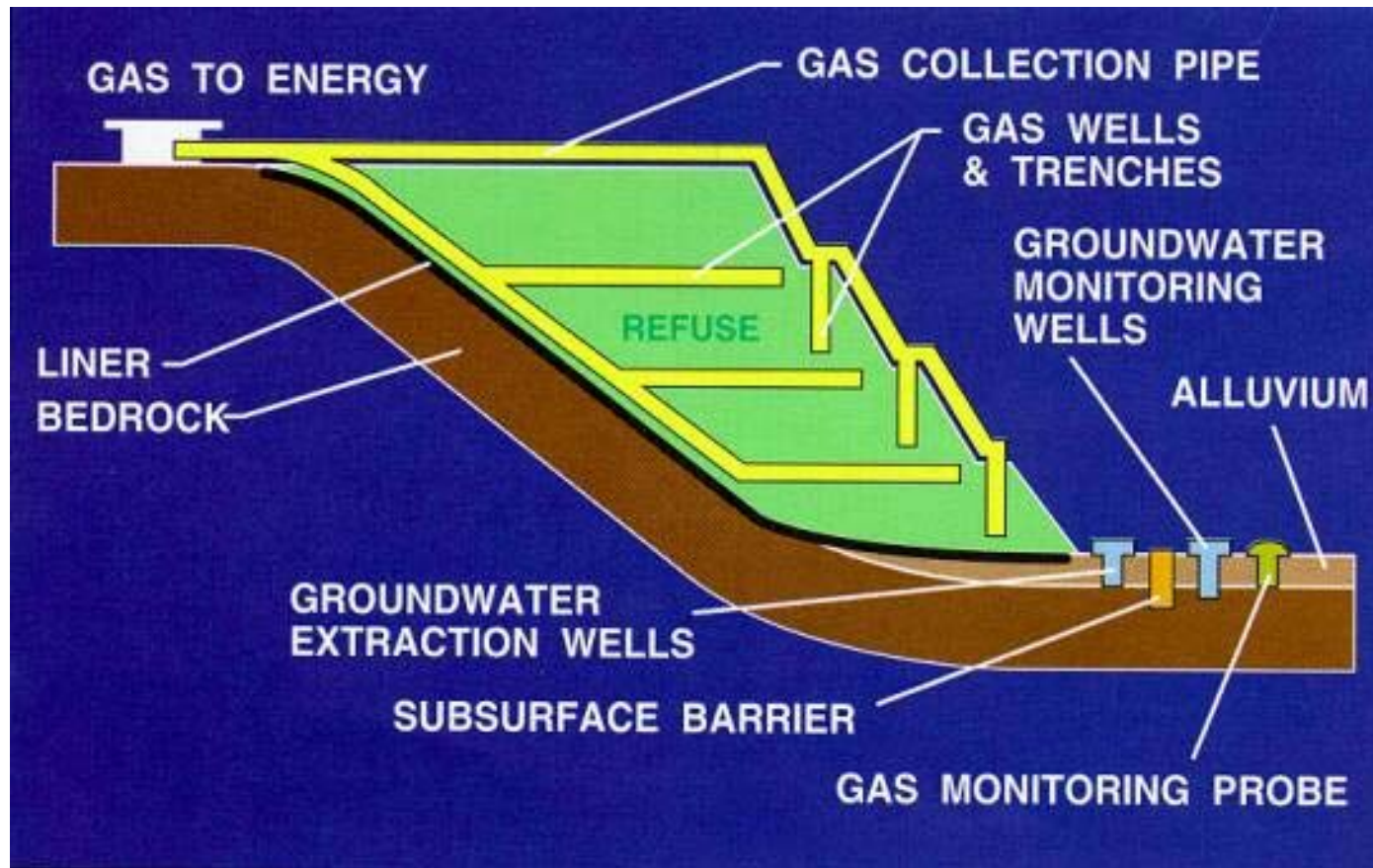
- ⌘ Receive non-hazardous solid waste
- ⌘ Cover refuse daily to eliminate odors and vectors
- ⌘ Organic refuse decomposes anaerobically to form CH_4 and CO_2
- ⌘ Site must be maintained for at least 30 years after closure



Daily Cover



Landfill Gas Collection



Surface Gas Monitoring



Landfill Gas Collection: Objectives



- ⌘ Control odors (good neighbor policy)
- ⌘ Prevent migration of explosive gases offsite
- ⌘ Minimize surface emissions
- ⌘ Meet applicable regulatory requirements
- ⌘ Energy recovery
- ⌘ Greenhouse gas control (new)

Gas Collection Trade-offs



- ⌘ Need enough vacuum to collect all the methane
- ⌘ Too much vacuum can lead to:
 - ☑ Composting/aerobic decomposition
 - ☑ Decreased methane production
 - ☑ Methane levels too low for beneficial use of gas

Landfill Population in California



- ⌘ Data from CIWMB

- ⌘ Landfills > 5 million tons in place

 - ☑ 51 landfills, 76% of total waste

 - ☑ All have controls

- ⌘ Landfills > 1 million tons in place

 - ☑ 150 landfills, 95% of total waste

 - ☑ 87% have controls

- ⌘ 94% of total waste in place has gas collection and control

Landfill Gas Resources in California



- ⌘ Data from EPA LMOP database
- ⌘ Existing: 67 projects, 264 MW
- ⌘ Potential: 46 projects, 170 MW
- ⌘ Impediments to development:
 - ☒ Economics-plant size, power price
 - ☒ Gas quality
 - ☒ Air quality requirements

GHG Emissions from Landfills

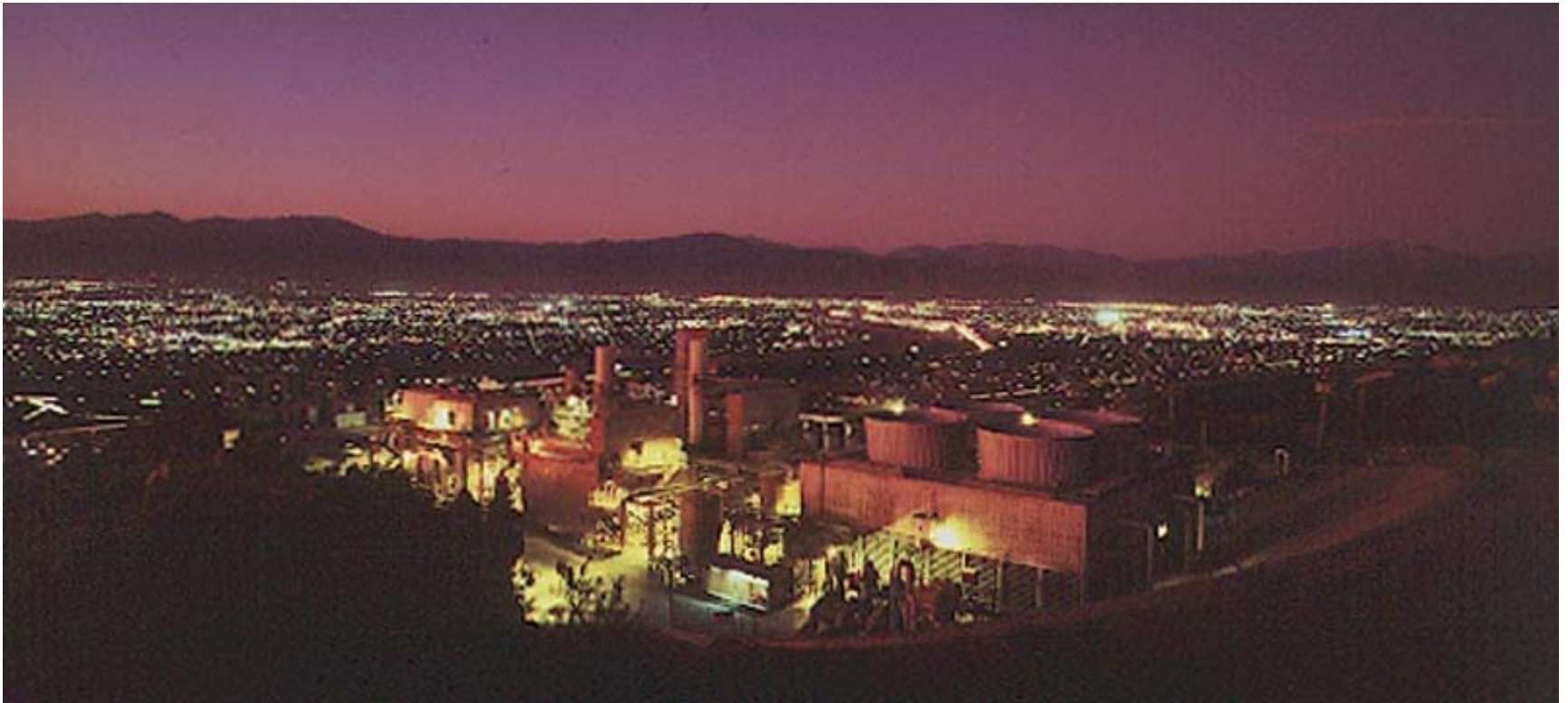


- ⌘ Draft Climate Action Team Report: landfills emit 2% of GHG in California
 - ☒ Report used default collection efficiency of 75%
 - ☒ Actual values for controlled landfills are 90 to >99%
- ⌘ At 95% efficiency, methane emissions are 80% lower than at 75% efficiency
- ⌘ More study is ongoing; accurate emission numbers are critical to planning efforts
- ⌘ The “low hanging fruit” has been picked
- ⌘ Gas generation models tend to over predict
- ⌘ Methane formation rate slows at closed landfills

Basic Landfill Gas Treatment: Incineration in Flares



Landfill Gas Treatment: Combustion for Energy Production



LFG to LNG: Bowerman Landfill (Orange County)



Beneficial Uses of LFG



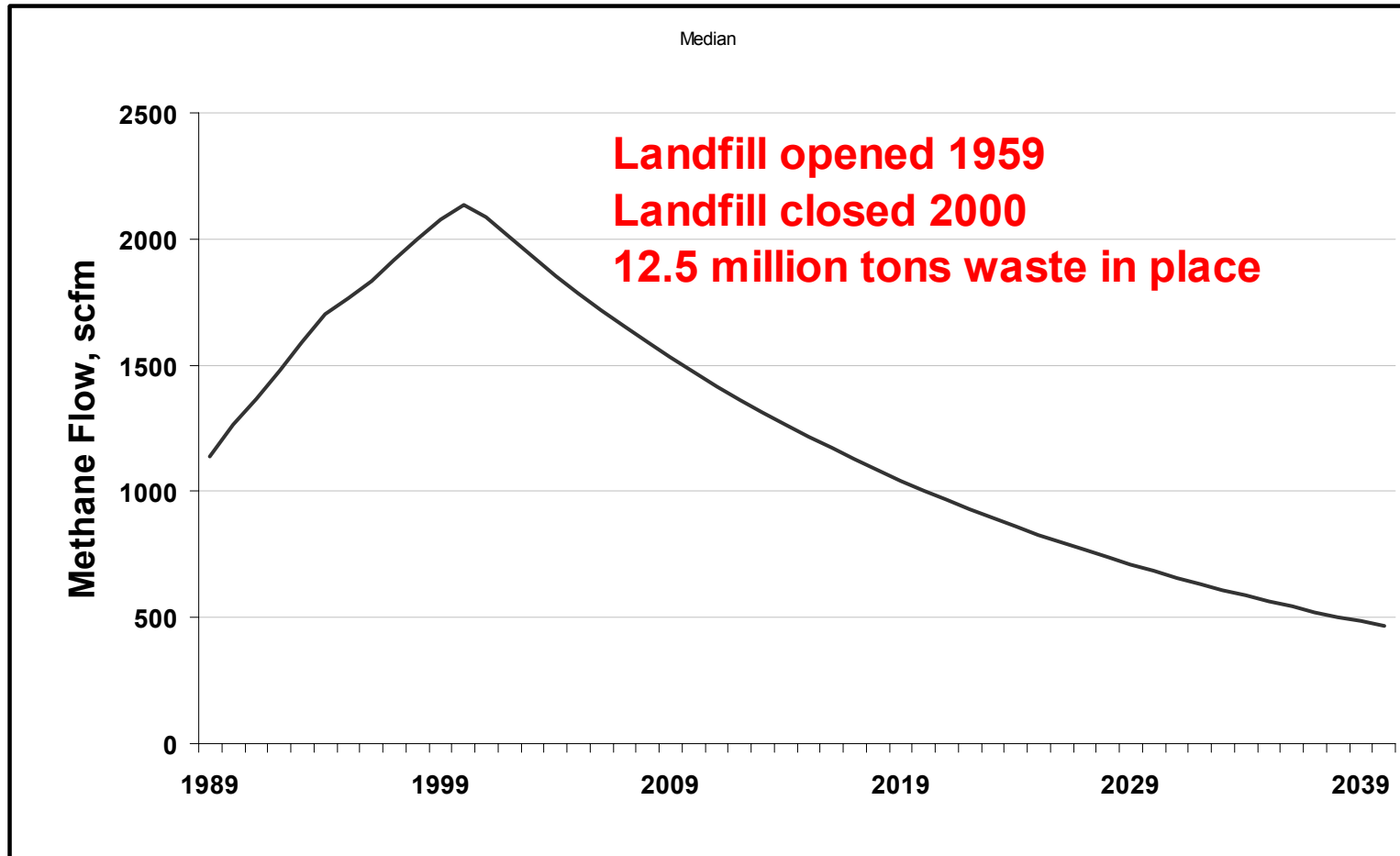
- ☒ Direct Use-limited in California
- ☒ Pipeline Sales-utility barriers
- ☒ Power Generation
 - ☒ IC engines: 800 kW and larger
 - ☒ Combustion turbines: 3 MW and larger
 - ☒ Microturbines: 30-750 kW
 - ☒ Small IC engines: 100 kW-1 MW
 - ☒ Boilers: 20 MW and larger
- ☒ Combined heat and power-very limited application
- ☒ Vehicle Fuel
 - ☒ LNG and CNG facilities starting to be developed
 - ☒ Other fuels such as hydrogen or methanol are not proven, have limited markets

Minimum Methane Requirements



- ⌘ Engines: 35-50%
- ⌘ Turbines: 35%
- ⌘ Microturbines: 35-50%
- ⌘ Fuel cell: 45%
- ⌘ Flares: 8-15%
- ⌘ LNG: 45%
- ⌘ Boilers: 12%

Typical Landfill Gas Generation Curve



GHG Benefits of LFG Utilization



- ⌘ Since methane is already largely controlled, largest GHG benefit is from beneficial use of LFG as opposed to flaring
- ⌘ This benefit is in the form of CO₂ reductions from offsetting fossil fuel use for power generation or vehicle fuel

Estimated Costs of Landfill Gas Control, \$/ton eq CO₂



- ⌘ These estimates are for control of methane emissions by installation of a gas collection and treatment system
- ⌘ New system at a small or old uncontrolled landfill
 - ☐ \$10-100/ton
- ⌘ Existing landfill controls in California:
 - ☐ \$2-10/ton

Estimated Benefits of Landfill Gas Utilization, \$/ton eq CO₂

- ⌘ These values represent net income per ton CO₂ displaced by recovered energy
- ⌘ Calculations are for an active midsize landfill, using EPA LMOP model
- ⌘ Replace flaring with power generation at medium-large landfill
 - ☒ \$(140)/ton net income
- ⌘ Replace flaring with LNG production at medium-large landfill
 - ☒ \$(570) \$/ton net income

Challenges and Obstacles



⌘ Electricity Generation

- ☒ Difficult power sales process in California
- ☒ SCAQMD proposed rule on engine emissions

⌘ Vehicle Fuels

- ☒ First large scale projects are just now coming on line

⌘ Direct Usage

- ☒ Limited markets, utility barriers

⌘ Small uncontrolled landfills

- ☒ Diminishing returns

Conclusions



- ⌘ GHG emissions in California are already almost completely controlled
- ⌘ California is a national leader in energy recovery from landfill gas, but there is still significant undeveloped potential
- ⌘ Current estimates of statewide landfill methane emissions are high
- ⌘ Beneficial use of LFG offers benefits by offsetting fossil fuel use
- ⌘ There are significant financial, technical, and regulatory barriers to project implementation

Questions?

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